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In re Japanese Document of

CLAIMS, and paragraph 0013 to paragraph 0042 of the specification of JP 2002-334618

VERIFICATION OF TRANSLATION

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Washington, D.C. 20231

Sir:

Kazuhiko SUGA residing at c/o WAKABAYASHI PATENT AGENCY, 16th Kowa Bldg., No. 9-20, Akasaka 1-chome, Minato-ku, Tokyo, Japan

declares:

(1) that he knows well both the Japanese and English languages;

(2) that he translated the above-identified Japanese Document from Japanese to English;

(3) that the attached English translation is a true and correct translation of the above-identified Japanese Document to the best of his knowledge and belief; and

(4) that all statements made of his own knowledge are true and that all statements made on information and belief and believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 USC 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereof.

April 13, 2009
Date

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[CLAIMS]

[Claim 1] A process for forming a conductive metal thin film using fine metal particle dispersion, which metal thin film is substitutionally used for a metal plating film, characterized in that:

the process comprising:

a step of forming a coating layer of said fine metal particle dispersion on the region where a conductive film to be substitutionally used for the metal plating film is to be formed; and

a step of subjecting the formed coating layer of the fine metal particle dispersion to heat-treatment at a temperature being no higher than 250°C to sinter the fine metal particles with each another contained therein;

wherein said fine metal particle dispersion used in the process is such a dispersion comprising an organic solvent that is used as a dispersion medium and a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in the organic solvent,

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

when the heat-treatment is carried out, the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is detached from the surface of the fine metal particle.

[Claim 2] The process according to claim 1,

wherein a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion, and

the detachment of the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom from the surface of the fine metal particle is accelerated by the reaction of the compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom to the compound having the group containing the nitrogen, oxygen or sulfur atom.

[Claim 3] The process according to claim 2,

wherein an organic acid anhydride or a derivative thereof or an organic acid is used as said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion.

[Claim 4] The process according to claim 1 or 2,

wherein said fine metal particle contained in the fine metal particle dispersion is a fine particle made of a metal selected from the group consisting of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals.

[Claim 5] A fine metal particle dispersion being usable to form a conductive film, which film is substitutionally used for a metal plating film, characterized in that:

said fine metal particle dispersion comprises a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in an organic solvent that is used as a dispersion medium thereof,

wherein

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is capable of being detached from the surface of the fine metal particle by heat-treatment at a temperature being no higher than 250°C.

[Claim 6] The fine metal particle dispersion as claimed in claim 5;

wherein a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion.

[Claim 7] The fine metal particle dispersion as claimed in claim 6;

wherein said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion, is an organic acid anhydride or a derivative thereof or an organic acid.

[Claim 8] The fine metal particle dispersion as claimed in claim 5 or 6; wherein said fine metal particle contained in the fine metal particle dispersion is a fine particle made of a metal selected from the group consisting of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals.

[Claim 9] A process for mounting an electronic part on a substrate, characterized in that:

the process comprising a step of mounting the electronic part so as to electrically connect the part to a circuit for wiring formed on the substrate, in which electric conduction is achieved by using a conductive metal thin film;

wherein said conductive metal thin film formed on the substrate is formed by the process as claimed in any one of claims 1 to 4.

[Claim 10] The process according to claim 9,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to be formed through holes connecting between the top surface and rare surface of the substrate.

[Claim 11] The process according to claim 9,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to compose at least a portion of the circuit for wiring formed on the substrate.

[Claim 12] The process according to claim 9,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to be used as a bonding pad for connecting between the wiring of the electronic part and the circuit of wiring formed on the substrate.

[0013]

Hence, a process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention is:

a process for forming a conductive metal thin film using fine metal particle dispersion, which metal thin film is substitutionally used for a metal plating film, characterized in that:

the process comprising:

a step of forming a coating layer of said fine metal particle dispersion on the region where a conductive film to be substitutionally used for the metal plating film is to be formed; and

a step of subjecting the formed coating layer of the fine metal particle dispersion to heat-treatment at a temperature being no higher than 250°C to sinter the fine metal particles with each another contained therein;

wherein said fine metal particle dispersion used in the process is such a dispersion comprising an organic solvent that is used as a dispersion medium and a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in the organic solvent,

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

when the heat-treatment is carried out, the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is detached from the surface of the fine metal particle.

[0014]

In the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention,

it is preferred that the process is characterized by:

a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion, and

the detachment of the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom from the surface of the fine metal particle is accelerated by the reaction of the compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom to the compound having the group containing the nitrogen, oxygen or sulfur atom. In such a case, an organic acid anhydride or a derivative thereof or an organic acid is preferably used as said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion.

[0015]

On the other hand, the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, may include

such an embodiment of the process,

wherein, in accordance with the material of the plating film to be substituted therewith, said fine metal particle contained in the fine metal particle dispersion is a fine particle made of a metal selected from the group consisting

of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals.

[0016]

In addition, the present invention provides an invention of a fine metal particle dispersion that is used for the process for formation of the conductive metal film as defined by the aforementioned features, which process is used substitutionally for plating. Namely, the fine metal particle dispersion according to the present invention is:

a fine metal particle dispersion being usable to form a conductive film, which film is substitutionally used for a metal plating film, characterized in that:

said fine metal particle dispersion comprises a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in an organic solvent that is used as a dispersion medium thereof,

wherein

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is capable of being detached from the surface of the fine metal particle by heat-treatment at a temperature being no higher than 250°C.

[0017]

In the case of the fine metal particle dispersion according to the present invention,

it is preferred that the fine metal particle dispersion is characterized by:

a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion. In such a case, said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion, is preferably an organic acid anhydride or a derivative thereof or an organic acid.

[0018]

On the other hand, the fine metal particle dispersion according to the present invention, may include

such an embodiment of the fine metal particle dispersion,

wherein, in accordance with the material of the plating film to be substituted therewith, said fine metal particle contained in the fine metal particle dispersion is a fine particle made of a metal selected from the group consisting of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals.

[0019]

In addition, the present invention provides an invention of a process for mounting an electronic part on a substrate by using said that is substitutionally used for plating film, which process is considered as embodiment of practical use of the aforementioned process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention. Hence, the process for mounting the electronic part according to the present invention is:

a process for mounting an electronic part on a substrate, characterized in that:

the process comprising a step of mounting the electronic part so as to electrically connect the part to a circuit for wiring formed on the substrate, in which electric conduction is achieved by using a conductive metal thin film;

wherein said conductive metal thin film formed on the substrate is formed by the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, which is defined by any of modes as stated above.

[0020]

The process for mounting the electronic part according to the present invention may include

such an embodiment of the process,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to be formed through holes connecting between the top surface and rare surface of the substrate;

such another embodiment of the process,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to compose at least a portion of the circuit for wiring formed on the substrate; and

such a further embodiment of the process,

wherein the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to be used as a bonding pad for connecting between the wiring of the electronic part and the circuit of wiring formed on the substrate.

[0021]

[Mode for Carrying Out the Invention]

Hereinafter, the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, and the fine metal particle dispersion in the form of paste, which is usable in the process will be further explained to details.

[0022]

The main use of the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, is substitutional use of the thin film of the sintered product made of the fine metal particle, which is produced by sintering at a relatively low temperature, for the metal thin film comprised in the components in which the metal thin film formed by a conventional plating method has been used, in the filed of electronic material. Therefore, as for the thin film of the sintered product of the fine metal particles itself, which film is used for the purpose, it is desirable that the

film formed is a thin film of the sintered product of the fine metal particles, which have an average particle diameter comparable as the size of the metal grain precipitated in the plating film for which it should substitute. Thus, as to the fine metal particle to be contained in the fine metal particle dispersion in the form of paste that is used in the process, the average particle diameter thereof is selected in the range of 1-100 nm, according to the target thickness of the plating film to be substituted therewith. Preferably, the average particle diameter thereof is chosen within the range of 2-10 nm.

[0023]

Such a fact that fine metal particles having an average particle diameter of several nanometers to several tens nanometers will generally sinter with each another at a remarkably lower temperature that its melting point (for instance, at 200°C in the case of silver) is known. This low-temperature sintering is caused by the following phenomena: in the case where the particle diameter of the fine metal particle is sufficiently decreased, ratio of atoms being present in the state of high energy to total atoms being present on the surface is increased, and thus the surface diffusion of the metal atoms is by no means in negligible level; as a result, the extension of the interface between the fine particles are induced by the surface diffusion, which promotes the sintering. On the other hand, this feature will cause such a phenomenon that, in the case if the surfaces of the fine metal particle are in direct contact with each other, aggregates thereof are easily formed at a temperature around room temperature. Said aggregate formation will be a retarding factor which injures such a effect as improvement in film thickness homogeneity, which will be attained as a result of the advantage that very fine metal particlesvery are capable of forming a dense filling state. Further, the formation of the dense

filling state causes such advantage that a desired conductivity will be attained as a whole. However, in the case if such a structure in which the aggregates are partially formed in advance is included in the coating film, the structure will be a factor which prevents the achievement of the dense filling state with high reproducibility.

[0024]

Therefore, in the step where, by using the fine metal particle dispersion used for the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, the coating film of the fine metal particle dispersion in the form of paste is formed on the surface of a target such as a printed-circuit board, it is necessary that the formation of the aggregate from the fine metal particles contained in the dispersion is prevented in keep the fine metal particles in the uniform dispersion state. For this purpose, the surface of the fine metal particle contained therein is kept in such a state that it is covered with one or more kinds of compounds that have the group containing of the nitrogen, oxygen or sulfur atom, as a group capable of forming a coordinative bond with a metal element contained in the fine metal particle. As the metal surface of the fine metal particle is to be densely covered with the one or more kinds of compounds that have the group containing of the nitrogen, oxygen or sulfur atom, as a group capable of forming a coordinative bond with a metal element contained in the fine metal particle, the fine metal particles will be kept in such a state that the metal surface thereof are by no means in direct contact with each another, until it is subjected to heat-treatment after the formation of the coating film. Furthermore, as the covering layer is provided thereon, the fine metal particles will be kept in such a state that any oxidation film is not

substantially formed on the surface of the fine metal particle, even if the surface is accidentally in contact with oxygen at the step of coating.

[0025]

The compound used for covering the metal surface utilizes a group having a lone pair on a nitrogen, an oxygen or a sulfur atom to form a coordinative bond with a metal element. Examples of groups containing a nitrogen atom include an amino group. Examples of groups containing a sulfur atom include a sulfanyl group (-SH) and a sulfide-type sulfane-di-yl group (-S-). Examples of groups having an oxygen atom include a hydroxyl group (-OH) and an ether-type oxy group (-O-).

[0026]

Typical examples of usable compounds having an amino group include alkylamine. Among the alkylamine, suitable is one that does not come off in a normal storage environment, more specifically, at a temperature lower than 40°C, once it comes into the state of forming a coordinate bond to a metal element, and thus an alkylamine having a boiling point in the range of 60°C or higher, preferably of 100°C or higher is suitable. On the other hand, since the alkylamine must come off quickly from the metal surfaces when the step of sintering or alloying by heat-treatment is carried out , such a alkylamine having a boiling point selected at least from a range of not higher than 300°C, generally from a range of not higher than 250°C, is preferred. For example, as to the alkylamine above-mentioned, such an alkylamine with alkyl group of C_4 to C_{20}, more preferably being selected from a range of C_8 to C_{18}, and having an amino group at terminals of its alkyl chain is usable. For example, since said alkylamine selected from a range of C_8 to C_{18} has thermal stability and its vapor

pressure is not so high, it is also easy to keep and control its content within a desired range during storage at room temperature or the like, and therefore such an alkylamine is suitably used due to its ease of handling. In general, a primary amine type compound is preferred in forming the coordinate bond since it exhibits a higher bonding capability, while compounds of secondary and tertiary amine type may also be used. Further, compounds having two or more adjacent amino groups that are involved in their bonding, such as 1,2- and 1,3-diamine type compounds, may also be used.

[0027]

On the other hand, typical examples of usable compounds having a sulfanyl group (-SH) include an alkanethiol. Among the alkanethiols, suitable is one that does not come off in a normal storage environment, more specifically, at a temperature lower than 40°C, once it comes into the state of forming a coordinate bond to a metal element, and thus an alkanethiol having a boiling point in the range of 60°C or higher, preferably of 100°C or higher is preferred. However, since the alkanethiol must come off quickly from the metal surface when the step of sintering or alloying by heat-treatment is carried out, such an alkanethiol having a boiling point selected at least from a range of not higher than 300°C, generally from a range of not higher than 250°C is preferred. For example, as to the alkanethiol above-mentioned, such an alkanetiol with alkyl group of C_4 to C_{20}, more preferably being selected from a range of C_8 to C_{18}, and having an amino group at terminals of its alkyl chain is usable. For example, since said alkanethiol selected from a range of C_8 to C_{18} has thermal stability and its vapor pressure is not so high, it is also easy to keep and control its content within a desired range during storage at room temperature or the like, and therefore such an alkanethiol is suitably used due

to its ease of handling. In general, a primary thiol type compound is preferred in forming the coordinate bond since it exhibits a higher bonding capability, while compounds of secondary and tertiary thiol type may also be used. Further, compounds having two or more sulfanyl groups (-SH) that are involved in their bonding, such as 1,2-dithiol type compounds, may also be used.

[0028]

Further, typical examples of usable compounds having a hydroxyl group include an alkanediol. Among the alkanediols, suitable is one that does not come off in a normal storage environment, more specifically, at a temperature lower than 40°C, once it comes into the state of forming a coordinate bond to a metal element, and thus an alkanediol having a boiling point in the range of 60°C or higher, preferably of 100°C or higher is preferable. However, since the alkanediol must come off from the metal surface when the step of sintering or alloying by heat-treatment is carried out, such an alkanediol having a boiling point selected at least from a range of not higher than 300°C, generally from a range of not higher than 250°C is preferred. For instance, compounds having two or more hydroxy groups that are involved in their bonding, such as 1,2-diol type compounds, may be more preferably used.

[0029]

In addition, such a compound component which has reactivity to a group containing a nitrogen, oxygen or sulfur atom, when carrying out the heat-treatment for the aforementioned compound having the group containing the nitrogen, oxygen or sulfur atom as a group capable of coordinate-bonding to a metal element, which is coating the surfaces of the fine metal particles, for instance, an organic acid anhydride or a derivative thereof or an organic acid, may be added in the fine metal particle dispersion. The compound having

reactivity to the group containing the nitrogen, oxygen or sulfur atom is used to remove, when heated, said coating layer covering the surfaces of the fine metal particles which are formed of the compound having the group containing the nitrogen, oxygen or sulfur atom as a group capable of coordinate-bonding to a metal element. That is, when heated, it reacts with the group containing the nitrogen, oxygen or sulfur atom in the coating compound which forms the coating layer around room temperature, and as a result of the reaction, it becomes difficult for the reacted group containing the nitrogen, oxygen or sulfur atom to form a coordinate bond to a metal atom on the surface of the fine metal particle, so that the coating layer is eventually removed. This removing capability is not exhibited around room temperature where the step of forming the coating film of the fine metal dispersion in the form of paste is carried out, but is to be first exhibited in the step of subjecting the coating film to heat-treatment.

[0030]

Specifically, the acid anhydride or acid anhydride derivative added therein is used to form an amide, thioester or ester by reacting with the compound having the group containing the nitrogen, oxygen or sulfur atom such as an amine compound, thiol compound or diol compound under heating. Once formation of such amide, thioester or ester takes place, it becomes difficult for them to form the coordinate bond to the metal atom, so that the coating layer on the surface of the fine metal particle is removed as result. Therefore, at first, the very fine metal particle is dispersed uniformly from the first, and then as the organic solvent contained in a coating film is gradually evaporated out, the particle can take a closely packing state so as to fill; and as the heat treatment proceeds, the metal surfaces make direct contact with each

other, and thus the fine metal particles undergo sintering even at a relatively low temperature. As a result, whole fine metal particles contained in the coating film are converted into a thin film of dense sintered product, the density of the thin film is comparable with that of the plating film.

Accordingly, the acid anhydride or acid anhydride derivative used for the reaction with the compound having the group containing the nitrogen, oxygen or sulfur atom at the step of removing the above coating layer is preferably added at least in an amount larger than the equivalent, on basis of the total amount of terminal amino groups, sulfanyl groups (-SH) or hydroxyl groups contained in such a compound as amine compound, thiol compound or diol compound mentioned above. In some cases, the acid anhydride or acid anhydride derivative may also react with a thin film of basic metal oxide when heated and have a function of producing a metal salt of a carboxylic acid thereof. Thus, in consideration of the reactivity, a slightly excessive amount is selected as appropriate.

[0031]

As long as the reactivity explained above is exhibited, an organic acid anhydride or derivative thereof or organic acid to be used is not particularly limited. For instance, examples of usable organic acids may include C_1 to C_{10} linear or branched saturated carboxylic acids such as formic acid, acetic acid, propionic acid, butanoic acid, hexanoic acid and octyl acid, unsaturated carboxylic acids such as acrylic acid, methacrylic acid, crotonic acid, cinnamic acid, benzoic acid and sorbic acid, and also dibasic acids such as oxalic acid, malonic acid, sebacic acid, maleic acid, fumaric acid, and itaconic acid, and in addition to variety of carbonic acids, other organic acids having a phosphoric

group (-O-P(O)(OH)$_2$) or sulfonic group (-SO$_3$H) in place of a carboxyl group such as a phosphoric ester and a sulfonic acid.

[0032]

Further, examples of organic acid anhydrides and organic acid anhydride derivatives which can be suitably used include aromatic acid anhydrides such as phthalic anhydride, trimellitic anhydride, pyromellitic anhydride, benzophenone tetracarboxylic anhydride, ethylene glycol bis(anhydrotrimellitate) and glycerol tris(anhydrotrimellitate), alicyclic acid anhydrides such as maleic anhydride, succinic anhydride, tetrahydrophthalic anhydride, methyl-tetrahydrophthalic anhydride, methylnadic anhydride, alkyl-succinic anhydride, alkenyl-succinic anhydride, hexahydrophthalic anhydride, methyl-hexahydrophthalic anhydride and methyl-cyclohexenetetracarboxylic anhydride, and aliphatic acid anhydrides such as polyadipic anhydride, polyazelaic anhydride and polysebacic anhydride. Among these, methyl-tetrahydrophthalic anhydride, methyl-hexahydrophthalic anhydride, and their derivatives are suitably used because they have moderate reactivity with, for example, terminal amino groups of an amine compound even at a relatively low temperature for heat treatment (sintering) which is a target of the present invention.

[0033]

In the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, after the step of coating, the fine metal particle dispersion in the form of paste used therein is subjected to the heat-treatment, but at the step of coating, the dispersion should contain one or more organic solvents as a dispersion medium in which the fine metal particle provided with the covering layer

composed of the aforementioned molecules on the surface. It is preferred to keep such state that said compound component having the reactivity to the group containing the nitrogen, oxygen or sulfur atom is uniformly dissolved in the organic solvent. On the other hand, in order to keep the fine metal particle provided with the covering layer composed of the aforementioned molecules on the surface in the state of uniform dispersion while keeping the fine metal dispersion in the form of paste over a long time period, such an organic solvent that is not capable of quickly eluting out the covering layer composed of the compound such as amine compounds, which is used to coat over the surface of the fine metal particle, is suitably used.

[0034]

As for the organic solvent used for these two purposes, different organic solvents may be used, but it is preferred that the same organic solvent is used. The organic solvent is not limited to a particular type as long as it is applicable for said two types of uses. It is preferable to select a nonpolar solvent or low polar solvent, rather than a high polar solvent in which the compound forming the coating layer on the surfaces of the fine metal particles, for example, such as an alkylamine, is so highly soluble that the coating layer on the surfaces of the fine metal particles may vanish away.

[0035]

In the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, in addition, it is preferred that the organic solvent is capable of being relatively quickly evaporated and has has thermal stability to such an extent that it does not undergo thermal decomposition even at a high temperature where a heat treatment for sintering is carried out after the step of coating. Further, in the

case where a fine line is formed, as at the step of coating, the fine metal particle dispersion is applied by screen printing to form a coating film having a desired film thickness, the viscosity thereof must be kept within a desired liquid viscosity. Thus, in consideration of its ease of handling at such a step, a nonpolar solvent or low polar solvent with a relatively high boiling point which hardly evaporates around room temperature, for example, such as terpineol, a mineral spirit, xylene, toluene, ethylbenzene and mesitylene, is preferably employed, or hexane, heptane,octane, decane, dodecane, cyclohexane or cyclooctane may be also used therefor.

[0036]

The content of said organic solvent is chosen based on the quantity of the compound which has reactivity to the compound having the group containing the nitrogen, oxygen, or sulfur atom, for example, the organic acid anhydride, derivative thereof, or organic acid, which it should dissolve. The content ratio thereof is selected based on the quantity of the fine metal particle to be dispersed therein, and its dispersion density. In that case, it is usually preferred that, in the fine metal particle dispersion in the form of paste, the content of the organic solvent is selected in the range of 5 mass parts to 100 mass parts, per 100 mass parts of the fine metal particles, which is a dispersoid. Further, it is necessary to adjust the liquid viscosity of fine metal particle dispersion in the form of paste with a view to attaining appropriate performance for coating, such as line width accuracy and controllability of coating film thickness, and thus, it is desirable that the content of the organic solvent is suitably adjusted so as to select the liquid viscosity from the range of 1 to 500 Pa·s, preferably from the range of 2 to 200 Pa·s, in final.

[0037]

On the other hand, in view of the use and material of the plating film which is substituted with the conductive metal film to be formed, the fine metal particle having a fine average particle diameter to be contained in the fine metal particle dispersion in the form of paste may be appropriately selected from a fine particle made of a metal selected from the group consisting of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals. For the usual purpose, a fine particle made of a metal having excellent electrical conductivity, such as gold, silver, copper, and platinum, is very often employed. In the case where a fine particle made of an metal alloy is used, the effect of the present invention is exhibited usually by using a fine particle made of an metal alloy having a melting point that is higher than the temperature of the heat-treatment for sintering.

[0038]

Further, the process for mounting the electronic part, according to the present invention, is just such a process for assembling or mounting an electronic part on a board for assembling, in which the conductive metal film formed by using the aforementioned process for forming the conductive metal film, which is substitutionally used for plating, is newly employed to form the electronic material component that is conventionally prepared by using a plating film. Variety of plating films have been used to form the components for mounting an electronic part. In contrast with the conventional plaiting process, in the case where the heat-treatment used at the step of low-temperature sintering the fine metal particle, which step is a characteristic and indispensable step used in the process for formation of a conductive metal

film that is substitutionally used for plating, according to the present invention, leads to no interference, such a plating film can be substituted with the conductive metal film. In particular, the embodiment which shows such advantage that the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, by no means requires any wet process using an aqueous agent, in contrast with plating, is more preferred.

[0039]

For example, such embodiment in which selective formation of conductive metal film only on the specific region is required is more preferred. The series of steps of the process for mounting the electronic part on the substrate includes a step of mounting the electronic part so as to electrically connect the part to a circuit for wiring formed on the substrate, in which electric conduction is achieved by using a conductive metal thin film. In that case, such an embodiment in which the conductive metal thin film to be formed on the substrate is selectively formed only on the required portion by using the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, is preferred.

[0040]

Examples of the preferred embodiments include an embodiment in which the conductive metal thin film used to achieve the electric conduction therein is employed as a conductive metal thin film which is used substitutionally for a plating film that is to be formed through holes connecting between the top surface and rare surface of the substrate; an embodiment in which the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film

that is to compose at least a portion of the circuit for wiring formed on the substrate, and also an embodiment in which the conductive metal thin film used to achieve the electric conduction therein is such a conductive metal thin film which is used substitutionally for a plating film that is to be used as a bonding pad for connecting between the wiring of the electronic part and the circuit of wiring formed on the substrate. In addition, such a process in which the fine metal particle dispersion in the form of paste according to the present invention is coated on the substrate; and then the electronic part such as device chip is mounted on the portion being coated with the film, after that, the film is heated at a low temperature of 250°C or lower to sinter may be used to join the electronic part thereon with high reliability,

[0041]

In addition, in the process for mounting the electronic part according to the present invention, the fine metal particle dispersion in the form of paste used therein by no means employs any organic binder to electrically connect the fine metal particles to each another and to shape and adhere them in the film form. In contrast with the conductive metal paste which uses an organic binder, such an embodiment in which plurality of electronic parts are further mounted on the resulted conductive metal film by using a soldering agent may be selected.

[0042]

[Example]

Hereinafter, the present invention will be explained more specifically with reference to Examples. Although these Examples are examples of the best embodiments in the present invention, the scope of the present invention shall not be limited by these Examples.